CLAIMS:

1. A method comprising:

mapping auscultatory sounds associated with known physiological conditions to a set of one or more disease regions defined within a multidimensional space;

generating a set of one or more vectors within the multidimensional space representative of auscultatory sounds associated with a patient; and

outputting a diagnostic message associated with a physiological condition of the patient as a function of the vectors and the disease regions defined within the multidimensional space.

2. The method of claim 1, wherein outputting a diagnostic message comprises:

selecting one of the disease regions of the multidimensional space as a function of orientations of the vectors within the multidimensional space; and

outputting the diagnostic message based on the selection.

3. The method of claim 2, wherein each of the vectors correspond to a respective one of the disease regions, and wherein selecting one of the disease regions comprises selecting one of the disease regions as a function of a distance between each of the vectors and the respective disease region.

4. The method of claim 3, wherein selecting one of the disease regions comprises:

identifying which of the vectors has a minimum distance from its respective disease region; and

selecting the disease region associate with the identified vectors.

5. The method of claim 1, wherein each disease region within the multi-dimensional space is defined by characteristics of the auscultatory sounds associated with the known physiological conditions that have been identified as indicators for the respective physiological condition.

6. The method of claim 1, wherein outputting a diagnostic message comprises outputting a pass/fail message that indicates whether an abnormal physiological condition has been detected.

7. The method of claim 1, wherein outputting a diagnostic message comprises outputting a diagnostic message identifying one or more specific pathologies currently being experienced by patient.

8. The method of claim 1, wherein outputting a diagnostic message comprises outputting the diagnostic message to indicate the patient is susceptible to one or more of the physiological conditions.

9. The method of claim 1, wherein outputting a diagnostic message comprises selecting a message type for the diagnostic message based on a user configurable mode.

10. The method of claim 1, wherein the message type comprises one of a pass/fail message type, a suggested diagnosis message type, and a predictive diagnosis message type.

11. The method of claim 1, further comprising outputting a severity indicator based on a calculated distance from at least one of the vectors and a normal region within the multidimensional space.

12. The method of claim 1, wherein mapping auscultatory sounds comprises:

formulating a set of matrices that store digitized representations of the auscultatory sounds associated with the known physiological conditions, wherein each matrix is associated with a different one of the physiological conditions and stores the digitized representations of the auscultatory sounds associated with the respective physiological condition; and

applying singular value decomposition ("SVD") to each of the matrices to compute respective sets of sub-matrices that define the disease regions within the multidimensional space.

13. The method of claim 12, wherein each of the matrices comprises an NxM matrix storing N of the digitized representations and M digital values for each of the digitized representations.

14. The method of claim 12, wherein formulating a set of matrices comprises formulating the set of matrices to store digitized representations in a raw format that has not been filtered.

15. The method of claim 12, further comprising storing at least a portion of one or more of the sub-matrices within a database for use as configuration data for a diagnostic device.

16. The method of claim 15, further comprising storing the configuration data in a format that can be used by the diagnostic device to compute the vectors to represent the auscultatory sounds associated with the patient within the multidimensional space.

17. The method of claim 12, further comprising:

programming a diagnostic device in accordance with configuration data generated by the application of SVD to the set of matrices, wherein the configuration data includes at least one of the sub-matrices associated with the different physiological conditions; and

applying the configuration data with the diagnostic device to a digitized representation of the auscultatory sounds associated with the patient to produce the vectors within the multidimensional space.

18. The method of claim 12, wherein applying SVD comprises applying SVD to decompose a matrix $\boldsymbol{A}$ of the set of matrices into the product of three sub-matrices as:

$$A=UDV^T,$$

where $\boldsymbol{U}$ is an NxM matrix with orthogonal columns, $\boldsymbol{D}$ is an MxM non-negative diagonal matrix and V is an MxM orthogonal matrix.

19. The method of claim 18, further comprising:

computing a set of matrices ***T*** by pair-wise multiplying each of the computed ***U*** matrices with the other ***U*** matrices;

performing SVD on each of the resultant matrices ***T*** to decompose each matrix ***T*** into a respective set of sub-matrices; and

applying the sub-matrices generated from each of the matrices ***T*** to identify portions of the ***U*** matrices to be used in diagnosis of the patient.

20. The method of claim 19, wherein applying the sub-matrices generated from each of the matrices ***T*** comprises applying the sub-matrices generated from each of the matrices ***T*** to identify portions of the ***U*** matrices that maximize the orthogonality of the respective disease regions within the multidimensional space.

21. The method of claim 15, further comprising computing:

computing respective average vectors from the set of matrices, wherein each average vector represents an average of the digitized representations of the auscultatory sounds associated with the respective physiological conditions; and

applying the average vectors and the configuration data with the diagnostic device to the auscultatory sounds associated with the patient to generate the set of vectors within the multidimensional space.

22. The method of claim 21, wherein applying the average vectors and the configuration data with the diagnostic device comprises:

subtracting the corresponding average vectors from a vector representing the auscultatory sounds associated with the patient to generate a set of difference vectors, wherein each difference vector corresponds to a different one of the disease regions in the multi-dimensional space; and

applying the sub-matrices of the configuration data to the difference vectors to generate the vectors representative of the auscultatory sounds associated with the patient.

23. The method of claim 22, wherein applying the sub-matrices of the configuration data comprises multiplying the difference vectors by the corresponding one of the ***U*** sub-matrices to produce a respective one of the vectors representative of the auscultatory sounds associated with the patient.

24. The method of claim 1, wherein each of the auscultatory sounds associated with known physiological conditions comprises a digitized representation of sounds recorded over a plurality of heart cycles.

25. The method of claim 24, wherein mapping auscultatory sounds comprising:

processing each of the digitized representations to identify a starting point and ending point for each of the heart cycles;

processing each of the digitized representations to identify starting and ending times for systole and diastole periods of each of the heart cycles, and S1 and S2 periods for each of the heart cycles; and

re-sampling the digitized representations based on the identified starting and ending times for the systole and diastole periods and the S1 and S2 periods to normalize each of the heart cycles to a common heart rate.

26. The method of claim 1, wherein the physiological conditions include one or more of a normal physiological condition, aortic regurgitation, aortic stenosis, tricuspid regurgitation, tricuspid stenosis, pulmonary stenosis, pulmonary regurgitation, mitrial regurgitation, aortic aneurisms, carotid artery stenosis and mitrial stenosis.

27. The method of claim 1, further comprising:

capturing the auscultatory sounds associated with the patient using a first device;

communicating a digitized representation of the captured auscultatory sounds from the first device to a second device;

analyzing the digitized representation with the second device to generate the set of vectors; and

outputting the diagnostic message with the second device.

28. The method of claim 27, wherein the first device comprises an electronic stethoscope.

29. The method of claim 27, wherein the second device comprises one of a mobile computing device, a personal digital assistant, and an echocardiogram analyzer.

30. The method of claim 1, further comprising:

capturing the auscultatory sounds associated with the patient using an electronic stethoscope;

analyzing the digitized representation with the electronic stethoscope to generate the set of vectors; and

outputting the diagnostic message to a display of the electronic stethoscope.

31. The method of claim 1, wherein the physiological conditions comprise cardiac conditions and the auscultatory sounds associated with the patient comprises heart sounds.

32. The method of claim 1, wherein the auscultatory sounds associated with the patient comprises lungs sounds.

33. A method comprising:

applying singular value decomposition ("SVD") to digitized representations of auscultatory sounds associated with physiological conditions to map the auscultatory sounds to a set of one or more disease regions within a multidimensional space; and

outputting configuration data for application by a diagnostic device based on the multidimensional mapping.

34. The method of claim 33, wherein applying SVD further comprises:

formulating a set of matrices that store digitized representations of the auscultatory sounds associated with the physiological conditions, wherein each matrix is associated with a different one of the physiological conditions and stores the digitized representations of the auscultatory sounds associated with the respective physiological condition; and

applying SVD to each of the matrices to decompose the matrices into respective sets of sub-matrices that define the disease regions within the multidimensional space.

35. The method of claim 34, wherein outputting configuration data comprises storing at least a portion of one or more of the sub-matrices for each of the physiological conditions within a database.

36. The method of claim 34, wherein applying SVD comprises applying SVD to decompose a matrix $\boldsymbol{A}$ of the set of matrices into the product of three sub-matrices as:

$$A=UDV^T,$$

where $\boldsymbol{U}$ is an NxM matrix with orthogonal columns, $\boldsymbol{D}$ is an MxM non-negative diagonal matrix and V is an MxM orthogonal matrix.

37. The method of claim 36, further comprising:

computing a set of matrices $\boldsymbol{T}$ by pair-wise multiplying each of the computed $\boldsymbol{U}$ matrices with the other $\boldsymbol{U}$ matrices;

performing SVD on each of the resultant matrices $\boldsymbol{T}$ to decompose each matrix $\boldsymbol{T}$ into a respective set of sub-matrices; and

applying the sub-matrices generated from each of the matrices $\boldsymbol{T}$ to identify portions of the $\boldsymbol{U}$ matrices to be used in diagnosis of the patient.

38. The method of claim 37, wherein applying the sub-matrices generated from each of the matrices $\boldsymbol{T}$ comprises applying the sub-matrices generated from each of the matrices $\boldsymbol{T}$ to identify portions of the $\boldsymbol{U}$ matrices that maximize the orthogonality of the respective disease regions within the multidimensional space.

39. The method of claim 34, further comprising computing:

computing respective average vectors from the set of matrices, wherein each average vector represents an average of the digitized representations of the auscultatory sounds associated with the respective physiological conditions; and

generating the configuration data to include the average vectors.

40. The method of claim 33, wherein the physiological conditions include one or more of a normal physiological condition, aortic regurgitation, aortic stenosis, tricuspid regurgitation, tricuspid stenosis, pulmonary stenosis, pulmonary regurgitation, mitrial regurgitation, aortic aneurisms, carotid artery stenosis and mitrial stenosis.

41. A method comprising:

storing within a diagnostic device configuration data generated by the application of singular value decomposition ("SVD") to digitized representations of electrical recordings associated with physiological conditions, wherein the configuration data maps the electrical recordings to a set of one or more disease regions within a multidimensional space;

applying the configuration data to a digitized representation of an electrical recording associated with a patient to select one of the physiological conditions; and

outputting a diagnostic message indicating the selected one of the physiological conditions.

42. The method of claim 41,

wherein applying the configuration data comprises applying the configuration data to the digitized representation representative of the auscultatory sounds associated with the patient to generate a set of one or more vectors within the multidimensional space; and

wherein outputting a diagnostic message comprises outputting a diagnostic message as a function of the vectors and the disease regions defined within the multidimensional space.

43. The method of claim 42,

wherein applying the configuration data comprises selecting one of the disease regions of the multidimensional space as a function of orientations of the vectors within the multidimensional space; and

wherein outputting the diagnostic message comprises outputting the diagnostic message based on the selection.

44. The method of claim 43, wherein each of the vectors correspond to a respective one of the disease regions, and wherein selecting one of the disease regions comprises selecting one of the disease regions as a function of a distance between each of the vectors and the respective disease region.

45. The method of claim 41, wherein the configuration data comprises a sub-matrix generated by the application of SVD to the digitized representations of the auscultatory sounds associated with the known physiological conditions.

46. The method of claim 41, wherein the electrical recordings comprises echocardiograms.

47. The method of claim 41, wherein the electrical recordings comprises digitized representation of auscultatory sounds.

48. A diagnostic device comprising:

a medium that stores data generated by the application of singular value decomposition ("SVD") to digitized representations of auscultatory sounds associated with known physiological conditions; and

a control unit that applies the configuration data to a digitized representation representative of auscultatory sounds associated with a patient to select one of the physiological conditions, wherein the control unit outputs a diagnostic message indicating the selected one of the physiological conditions.

49. The diagnostic device of claim 48,

wherein the control unit applies the configuration data to the digitized representation representative of the auscultatory sounds associated with the patient to generate a set of one or more vectors within a multidimensional space having a set of defined disease regions, and

wherein the control unit selects one of the physiological conditions based on orientations of the vectors relative to the disease regions within the multidimensional space.

50. The diagnostic device of claim 49, wherein each of the vectors correspond to a respective one of the disease regions, and wherein the control unit selects one of the disease regions as a function of a distance between each of the vectors and the respective disease region.

51. The diagnostic device of claim 49, wherein the configuration data comprises a sub-matrix generated by the application of SVD to the digitized representations of the auscultatory sounds associated with the known physiological conditions.

52. The diagnostic device of claim 41, wherein the diagnostic device comprises one of a mobile computing device, a personal digital assistant, an echocardiogram analyzer, and an electronic stethoscope.

53. A data analysis system comprising:

an analysis module to apply singular value decomposition ("SVD") to digitized representations of electrical recordings associated with known physiological conditions to map the auscultatory sounds to a set of one or more disease regions within a multidimensional space; and

a database to store data generated by analysis module.

54. The method of claim 53, wherein the electrical recordings comprises echocardiograms.

55. The method of claim 53, wherein the electrical recordings comprises digitized representation of auscultatory sounds.

56. The data analysis system of claim 53,

wherein the analysis module formulates a set of matrices that store the digitized representations of the auscultatory sounds associated with the physiological conditions, wherein each matrix is associated with a different one of the physiological conditions and stores the digitized representations of the auscultatory sounds associated with the respective physiological condition, and

wherein the analysis module applies SVD to each of the matrices to decompose the matrices into respective sets of sub-matrices that define the disease regions within the multidimensional space, and

wherein the analysis module stores within the database at least one of the sub-matrices for each of the disease regions.

57. A computer-readable medium comprising instructions that cause a processor to:

apply configuration data to a digitized representation representative of auscultatory sounds associated with a patient to select one of a set of physiological conditions, wherein the configuration maps the auscultatory sounds to a set of one or more disease regions within a multidimensional space; and

output a diagnostic message indicating the selected one of the physiological conditions.

58. The computer-readable medium of claim 57 further comprising instructions to cause the processor to:

apply the configuration data to the digitized representation representative of the auscultatory sounds associated with the patient to generate a set of one or more vectors within the multidimensional space;

select one of the disease regions of the multidimensional space as a function of orientations of the vectors relative to the disease regions within the multidimensional space; and

output the diagnostic message based on the selection.